Data Necessary to Compute Radiological Risks from Flyash Associated with Yard 520

The data necessary for computing radiological risks from flyash associated with Yard 520 is incomplete. Only Uranium-238 and Uranium-235 were measured by ICPMS. There is no data at all for the Thorium (Th-232) Decay Series.

Available Data

Data for peak concentrations of uranium-238 and uranium-235 were measured by ICPMS.

Uranium-238 14.5 picocuries per gram (pCi/g)

Uranium-235 0.044 pCi/g

This data is of uncertain quality since the natural ratio for uranium-235 to uranium-238 (by activity) is 0.046. The ratio for this data is 0.030.

Background Determinations

To calculate excess risk, background concentrations must be subtracted from the above gross concentrations. Background concentrations can be determined somewhat.

For the Uranium Decay Series, the average measured background concentrations (measured by gamma spectrometry, not by ICPMS) are

U-238 0.317 pCi/g U-234 0.277 pCi/g Ra-226 0.280 pCi/g

For natural uranium these concentrations should all be equal. Thus, this data is of uncertain quality. Using the available data, the mean is

Mean, Uranium Decay Series 0.291 pCi/g
Net concentration 14.2 pCi/g (14.5 – 0.291)

These background and net concentrations will have to be used for each radionuclide in the decay series.

For the Thorium Decay Series, the only measured background values are for Radium-228. These are by gamma spectrometry, not ICPMS. The average background concentration is

Thorium Decay Series 0.339 pCi/g

Net concentration to be determined below

These background and net concentrations will have to be used for each radionuclide in the decay series.

For the Actinium Decay Series, the only measured values are for Uranium-235. These are by gamma spectrometry, not ICPMS. The average background concentration is

Actinium Decay Series background 0.052 pCi/g
Net concentration -0.008 pCi/g (0.044 – 0.052)

This data is of uncertain quality. The net concentration should be greater than zero.

These background and net concentrations will have to be used for each radionuclide in the decay series. Since the net concentration is less than zero, 0 pCi/g will be used for calculations.

Projections for Unmeasured Data

Since it is reasonable to assume that the two decay series which uranium-238 and uranium-235 initiate are in equilibrium, then all the radionucludes in the Uranium Decay Series (U-238) should be assigned a net activity concentration of 14.2 pCi/g. For example, this means U-234 and radium-226 (Ra-226) should be assigned an activity of 14.2 pCi/g.

Moreover, all the radionuclides in the Actinium Decay Series (U-235) should be assigned an activity concentration of 0.0 pCi/g since the calculated net activity concentration was less than zero.

Unmeasured were any radionuclides in the Thorium Decay Series (Th-232). These are essential for a valid risk assessment. An activity for these radionuclides can be projected, fortunately.

Gabbard from Oak Ridge National Laboratory wrote a paper (http://www.ornl.gov/info/ornlreview/rev26-34/text/colmain.html) in which he stated that "The amount of thorium contained in coal is about 2.5 times greater than the amount of uranium." This is based on weight (parts per million, ppm, not activity (pCi/g). The ratio should hold when coal is burned to flyash since the radioactive elements will not be altered. A conversion to obtain the activities for the Thorium Decay Series can be made.

First, convert the U-238 activity concentration to ppm. Conversions supplied through the Health Physics Society (http://www.hps.org/publicinformation/ate/q6747.html) can be used.

2.97 ppm, U-238, is equivalent to 1 pCi/g, U-238 9.08 ppm, Th-232, is equivalent to 1 pCi/g, Th-232

Thus, 14.2 pCi/g, U-238, is equivalent to 42.2 ppm (14.2 times 2.97).

And, 42.2 ppm, U-238, corresponds to 105.5 ppm, Th-232 (42.2 times 2.5) or 11.6 pCi/g (105.5 divided by 9.08), Th-232.

Finally, all the radionuclides in the Thorium Decay Series, including radium-228 (Ra-228) should be assigned an activity of 11.6 pCi/g.

In summary, computations for the radiological risk from Yard 520 flyash should use the net activity concentrations:

Uranium Decay Series (U-238) 14.2 pCi/g Thorium Decay Series (Th-232) 11.6 pCi/g Actinium Decay Series (U-235) 0.0 pCi/g

Once soil concentrations have been obtained, the risk from soil exposure should be computed. It should be assumed that all the radionuclides in each of the three natural decay series contribute to risk. The U.S. Environmental Protection Agency (EPA) has established radiological human health risk assessment guidance, radiological dose conversion factors, and radiological dose equivalent to risk factors. The most up-to-date guidance and coefficients should be used.